

A Prospective Analysis of Functional Outcomes of Closed Reduction and Percutaneous K-Wire Fixation Versus Conventional Plaster Cast Immobilization in the Treatment of Extra-Articular Fracture Distal end of Radius

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ABSTRACT

Background: Fracture of distal end of radius is among the commonest skeletal injury with diverse treatment options. There is no clear consensus on its outcome in comparison to closed reduction and casting versus percutaneous k-wire after reduction but it can be least cost effective options for managing for this common fracture in our developing country. Objective: To evaluate whether a more accurate reduction could be achieved by closed reduction supplemental percutaneous kirschner wire fixation and conventional plaster cast immobilization and to compare the functional outcome of the treatment of fracture distal end of radius.

Methods: 60 patients with distal end of radius fracture were selected and divided into two groups, group A (K-wire group): Patients with closed reduction and percutaneous K-wire fixation combined with plaster cast and group B (Cast group): Patients with closed reduction and conventional plaster cast immobilization randomly.

Results: All patients in the cast group showed signs of clinical union compared to k-wire group (96.66%) at 6 weeks. Meanwhile, all patients showed signs of both clinical and radiological union at subsequent 12 weeks follow up. **Conclusion:** Group treated with k-wire was more comfortable during the treatment period with less complication as compared to that of cast group and had a better functional as well as anatomical outcome. Regardless of the cost we recommend K-wire fixation over cast application in treatment of extra articular distal end radius fracture.

Keywords: Distal radius extra-articular fracture, Kirschner wire, Plaster cast.

INTRODUCTION

Fracture of distal end of radius is a common (nearly 16% of all fractures) skeletal injury conventionally treated by closed manipulation and plaster cast immobilization. However, difficulty in maintenance of reduction in plaster cast alone invariably results in mal-union and deformity leading to functional disability (like poor grip strength).^[1] Maintenance of radial length is one of the most crucial factors in regaining grip functions with shortening of greater than 4 to 6 mm compromising function.^[2]

Due to this inherent tendency for loss of reduction in distal radius fractures various measures (like use of percutaneous Kirschner wire fixation, external fixator application, internal fixation by plate and screw, bone grafting, bone cementing) have been reported to prevent re-displacement, but there is

much disagreement as to best modality.^[3,4] Even with excellent reduction gradual shortening at the fracture site has been reported as the healing occurs.^[5] It is found that after closed reduction, supplemental percutaneous Kirschner wire fixation secures initial reduction and maintains radial length till and prevents subsequent late collapse.^[6,7] The aim of this study is to determine whether a more accurate reduction could be achieved and retained during healing, as well as the predictors of collapse and whether the outcomes can be improved by closed reduction supplemental percutaneous kirschner wire fixation (CRPF) and conventional plaster cast immobilization and to compare the functional outcome with closed reduction and conventional casting versus CRPF supplemented with cast in terms of procedure time, pain, time to achieve union, time for functional recovery, complications, cost of treatment, material and method.

MATERIALS AND METHODS

60 subjects with closed traumatic extra-articular fracture of distal end of radius within the 7 days of injury in age group between 18 to 65 years were

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included in this study. Patients with bone or joint disease likely to affect outcome, patient not fit for anesthesia, patient with multiple bone fracture, severe comminution, pathological fractures were excluded from this study. Informed consent was obtained from the subjects willing to participate in the study. The subjects were then divided into 2 groups (30 subjects in each group) randomly using Excel random number generation technique. Group A (K-wire group): Patients with closed reduction and percutaneous K-wire fixation (CRPF) combined with plaster cast. Group B (Cast group): Patients with closed reduction and conventional plaster cast immobilization.

Intervention

Group A: Subjects underwent full investigations pertaining to pre-anesthetic checkup after admission. Following fitness for anesthesia closed reduction under image intensifier and fixation using percutaneous crossed K-wires (one through the radial styloid and other wire through proximal to distal radius fragment engaging the contralateral cortex) was performed electively followed by cast application. The patients were then monitored for 24 hours and appropriate antibiotics were instituted.

Group B: Subjects underwent full investigations pertaining to pre-anesthetic checkup. Following fitness for anesthesia, subjects underwent closed reduction under image intensifier followed by conventional plaster cast immobilization. The patients were then monitored for 24 hours.

The total duration of the procedure and anesthesia time were noted for both the groups. After the surgery/procedure any immediate post-operative complication(s) were noted. Patients in group A were given antibiotics for 24 hours. They were discharged after 24 hours. The subjects were then reviewed after 2 weeks (for pin tract infection in group A/other complications), 6 weeks, 12 weeks and 24 weeks. At 6 weeks, cast was removed in each group and sling was discarded. In each of the last three visits, patients were evaluated for pain, range motion, evidence of union, complications and subjective improvement using Quick DASH questionnaire. Patients were encouraged attend supervised physiotherapy programs by physiotherapists with special focus on shoulder, elbow, wrist, metacarpophalangeal and interphalangeal joints. Fresh radiograph were taken

at 6, 12 and 24 weeks post-operative visits and were evaluated for radiological parameters and signs of fracture healing.

Other variables like cost entire treatment (From time admission time discharge), clinical (by tenderness, transmitted movements) and radiological (comparing with normal side) signs of union, range of motion (at wrist, elbow and shoulder joint), radial length, radial inclination, ulnar variance and time taken for full functional range motion (if achieved) were also studied. Data was analyzed using SPSS 20.

RESULTS

A total of 174 patients presented with fracture of distal end of radius during the study duration out of which 104 patients had intra-articular fracture and 60 patients (38 males and 22 females) had extra articular fracture that were included in this study.

Table 1: Socio-demographic representation of the study population

Categories (In Years)	Number of patients	Percentage
Age	<25	12
	25-40	15
	41-55	22
	>55	11
Groups	Cast	K-Wire
	Mean Age (In Years) ± SD	P-value
39.53 ± 14.56	40.53 ± 14.23	0.789

Although RTA was the commonest form of injury leading to fracture of distal end of radius there was no statistically significant difference with other modes of injury. The length of procedure was significantly longer in subjects who underwent closed reduction with percutaneous k-wire fixation.

Table 2: Mode of Injury and mean time to procedure

Mode of Injury	Cast	K-wire	P-value
RTA	19	17	0.598
Fall From Height	9	9	
Playground Injury	2	4	
Mean injury to Procedure interval (in days) ± SD	1.44 ± 0.804	1.20 ± 0.286	0.128

Table 3: Comparison of radiological parameters, VAS, Quick DASH scores

Mean Radial Length (in mm) ± SD		Cast	K-wire	P-Value
Immediate Post-Operative	11.40 ± 1.23	11.70 ± 1.43	0.06	
	10.30 ± 0.95	11.47 ± 1.33	0.00	
	9.83 ± 1.83	11.80 ± 1.51	0.03	
	10.87 ± 1.87	11.80 ± 1.51	0.03	
Mean Dorsiflexion (in degrees) ± SD	20.00 ± 7.47	34.40 ± 6.97	0.000	
	44 ± 9.74	49.07 ± 10.15	0.054	
	57.70 ± 14.02	62.73 ± 9.501	0.109	

Mean Palmarflexion (in degrees) ± SD	6 weeks	26.87 ± 8.87	32.9 ± 12.81	0.039
	12 weeks	45.13 ± 6.45	48.73 ± 8.96	0.431
	24 weeks	49.43 ± 8.35	62.33 ± 10.23	0.434
Mean Ulnar Deviation (in degrees) ± SD	6 weeks	17.57 ± 6.17	19.93 ± 1.72	0.057
	12 weeks	22.57 ± 5.93	25.53 ± 1.10	0.387
	24 weeks	27.17 ± 4.80	29.27 ± 1.46	0.028
Mean Radial Deviation (in degrees) ± SD	6 weeks	9.20 ± 5.31	13.10 ± 2.38	0.001
	12 weeks	15.33 ± 4.65	18.20 ± 2.46	0.007
	24 weeks	17.93 ± 3.68	20.20 ± 2.25	0.115
Mean VAS Score(in Supination) ± SD	6 weeks	1.50 ± 2.55	0.53 ± 1.52	0.082
	12 weeks	0.73 ± 1.74	0.13 ± 0.50	0.079
	24 weeks	0.27 ± 0.59	0.0	0.043
Mean VAS Score(in Pronation) ± SD	6 weeks	2.37 ± 3.03	0.53 ± 1.52	0.005
	12 weeks	0.70 ± 1.75	0.27 ± 1.14	0.168
	24 weeks	0.33 ± 0.71	0.10 ± 0.54	0.160
Mean (Quick DASH scores) ± SD	6 weeks	32.26 ± 15.50	28.06 ± 12.76	0.387
	12 weeks	15.10 ± 9.68	11.38 ± 8.87	0.125
	24 weeks	2.18 ± 2.56	2.62 ± 7.50	0.771

Table 4: Complication at clinical union

At 6 weeks		Cast	K-wire	P-value
Clinical Union	Absent	0	1	0.313
	Present	30	29	
Radiological Union	Absent	4	5	0.717
	Present	26	25	

Table 5: Type of Complication

Type of Complications		Cast	Percentage Frequency	K-wire	Percentage Frequency
		Frequency		Percentage	
At 2 weeks	CTS	0	0	1	3.33
	Pin Track Infection	0	0	3	10
	Stiffness	30	100	5	16.56
At 6 weeks	CTS	0	0	1	3.33
	Pin Track Infection	0	0	2	6.66
	Stiffness	20	66.56	4	13.33
	CRPS	1	3.33	1	3.33
At 12 weeks	Stiffness	10	32.33	1	3.33
	CRPS	1	3.33	0	0
At 24 weeks	Complications (any of the above)	0	0	0	0

VAS in supination was comparable between the groups and showed a progressive significant decrease. Also, there was significant difference in VAS supination score at 24 weeks ($p=0.043$) at 24 weeks. VAS in pronation was significantly greater in cast group at 6 weeks ($p=0.005$) but it was later comparable at subsequent follow-ups. Meanwhile, there were no significant differences in terms of Quick DASH scores at any subsequent follow-ups. [Table 3]

DISCUSSION

Fracture of distal radius comprises more than 16% of all fractures with increased incidence on ageing.^[8,9] Elderly individuals constituted the bulk of the study population with the sharpest increase seen in both elderly females and younger adult males. Males constituted the majority of the study population (63.3%) in contrast to the even distribution mentioned by Lindau et al probably because male population in this part of the world is more commonly involved in outdoor activities leading to high energy trauma such as RTA.^[10] This study suggests that closed reduction followed by

cast application is a much shorter procedure compared to percutaneous K wire fixation which may be attributed to requirement of lesser technical demands when closed reduction followed by cast application is performed. This outcome might benefit the surgeons when deciding about treatment in special circumstances like polytrauma and comorbidities. Immediate post-operative radial length was found to be insignificantly higher in the cast group and radial inclination was found to be higher in k-wire group with difference in radial inclination in particular being highly significant ($p = 0.002$). Azzopardi et al,^[7] (2005) also noticed significant improvement in radial length and radial inclination with k wire fixation. A possible explanation can be longitudinal traction is transmitted mostly through volar radiocarpal ligaments correcting the radial length efficiently.

At 6 week follow up both the groups demonstrated loss of radial inclination, radial length and change in ulnar variance. This change however was significant only in cast group and but not so in K-wire group and was similar to loss of reduction in both the groups in later follow up radiographs which had also been noticed in studies done by

Azzopardi et al (2005).^[7] In our study we did not see further loss in radiological parameters beyond 6 weeks. The radiological parameters like radial length, radial inclination and ulnar variance remained to be significantly inferior in cast group at 6.12 and 24 weeks but this difference was not significant in K - wire at later follow ups of 6, 12 and 24 weeks. Rodriguesz-Merchan et al,^[6] and Azzopardi et al,^[7] showed similar result, at their study of colles' fracture treated by K wire method. Dorsiflexion, palmar flexion, ulnar deviation and radial deviation of wrist at 6 weeks were significantly restricted in cast group in comparison to K-wire group. However, both the groups showed highly significant improvement in wrist ROM at subsequent follow-ups of 12 and 24 weeks. Although the patients treated by K wire had a statistically significant early improvement in the range of movement of the wrist, this advantage diminished with time and in absolute terms the difference in range of movement was clinically unimportant.^[11] Stoffenlen and Broos conducted a prospective, randomized trial comparing closed reduction versus Kapandji pinning for extra-articular distal end radius fractures and found no difference in ROM between two groups.^[12] Also, the mobility of the wrist joint was not allowed until the cast was removed. However, as mobility was started much earlier in the K-wire group, less stiffness was observed in the wrist joint at 6 weeks and better ROM. The possible explanation for decrease ROM in cast group could be that the wrist was immobilized in slight palmar flexion and ulnar deviation.

VAS score in supination was comparable between the study groups at all the follow-ups and showed a progressive significant decrease in score at 12 weeks and 24 weeks of follow-up in comparison to the 6 weeks score. However, VAS score in pronation subsequently decreased progressively in both the groups and was found to be comparable at 12 and 24 week follow-ups. Such comparable VAS scores were also found by Krukhaug Y et al.^[13] Though none of the other studies known to have compared VAS scores in pronation and supination, few have measured forearm rotation in terms of pronation and supination.

Quick DASH scores were comparable at all the follow-ups and showed highly significant progressive decrease at subsequent follow-up ($p<.001$) similarly Gerell A et al,^[14] also found that Quick DASH score were similar in patients treated with a volar locking plate and external fixator. Other studies have taken DASH scores to find subjective outcome and Wright TW et al,^[15] agree to no significant difference between plating and external fixator group.

There was no significant difference in the union, both clinical and radiological, in the two groups. All the patients of cast group showed signs of

clinical union in comparison to 96.66% of K-wire group at 6 weeks. All the patients showed signs of both clinical and radiological union at subsequent 12 weeks follow-ups. Low CK et al,^[16] reported result of intrafocal pinning of 186 cases and found radiological union in 123 at 2 month, in 51 at 3 month and 3 cases at 4 month.

Stiffness remained the most common complication in both the groups. Supervised physiotherapy was advised to all the patients for stiffness leading to drop in the prevalence and stiffness resolved completely in all patients by 24 weeks. Stiffness as a common complication has also been reiterated by Hove LM et al (1997),^[17] who found that all patients had stiff wrist joints at three and six months, but most of them were considerably improved at 12 months. Increased affection with stiffness in cast group was possible due to immobilization of wrist in slight palmar flexion and ulnar deviation leading to no movements at wrist joint until its removal at 6 weeks. Also low attendance and lack of compliance to supervised physiotherapy program might be an added factor for high rates of stiffness in general.

The two patients with CRPS improved with stellate ganglion block and supervised physiotherapy and by 24 weeks both of them were free of symptoms. Frykman have suggested shoulder-hand-syndrome can be avoided by proper range of motion exercises during and after plaster cast immobilization in the treatment of distal radius fracture and this still holds true.^[18]

Pin-track infections were superficial and resolved with proper pin track dressing alone. Meanwhile, one case required additional oral antibiotics. We believe that the complications may be due to inadequate instruction and supervision given to patients with regard to pin-track care after discharge from the ward.

Higher rates of complications were seen in cast group than the group with K-wire. This observation accords with studies by Abramo A et al,^[8] in patients treated with conventional casting with respect to closed reduction and external fixation. Thus, the patterns of complications differ between the methods and might help an orthopedic surgeon to decide whether to use conventional casting or percutaneous K- wire fixation.

At last the cost of treatment by K- wire was significantly higher ($p<0,001$) than that of cast group, referring to cast being a cheaper procedure than K wire because of additional use of K- wire, cast and image intensifier in the K- wire group.

CONCLUSION

In this study we found that the final functional outcomes at 24 weeks were comparable in both the groups however the anatomical outcome were better in group treated with k wire. Complications

were higher in group treated with cast. We conclude that group treated with k wire was more comfortable during the treatment period with less complication as compared to that of cast group and had a better functional as well as anatomical outcome. Regardless of the cost we recommend K-wire fixation over cast application in treatment of extra articular distal end radius fracture.

Recommendation

Our study result recommends that closed reduction and casting verses percutaneous k-wire after reduction both treatment modalities can be used in compromised operation theater with in limited resources.

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